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(54) Title: A METHOD AND A DEVICE FOR DETECTING AN ABNORMALITY OF A HEAT EXCHANGER, AND THE USE OF SUCH A DEVICE

(57) Abstract: A method and a device for detecting an abnormality of a heat exchanger exchanging heat between a first fluid flow flowing in a conduit and a second fluid flow flowing along a flow path, said conduit and said flow path each having an inlet and an outlet, whereby the method comprises the steps of: establishing at least one parameter representative of the temperature conditions of the heat exchanger, establishing a second fluid inlet temperature, establishing a parameter indicative of expected heat exchange between the heat exchanger and the second fluid, processing the heat exchanger temperature, the second fluid temperature and the parameter indicative of expected heat exchange for establishing an estimated second fluid outlet temperature, employing the estimated second fluid outlet temperature for evaluating the heat exchange between the first and second fluids by comparing the estimated second fluid outlet temperature, or a parameter derived therefrom, with a reference value.

AMENDED CLAIMS

[Received by the International Bureau on 05 APR 2004 (05.04.04) ; original claims 1 and 9, amended ; original claims 1-8 and 10-15, unchanged]

1. A method for detecting an abnormality of a heat exchanger (3, 5) exchanging heat between a first fluid flow (7) flowing in a conduit (6) and a second fluid flow (8) flowing along a flow path (9), said conduit (6) and said flow path (9) each having an inlet and an outlet, characterized in comprising the steps of:

establishing at least one parameter representative of the temperature conditions of the heat exchanger (3, 5),

establishing a second fluid inlet temperature,

establishing a parameter indicative of expected heat exchange between the heat exchanger and the second fluid,

processing the at least one parameter representative of the temperature conditions of the heat exchanger, the second fluid inlet temperature and the parameter indicative of expected heat exchange for establishing an estimated second fluid outlet temperature,

employing the estimated second fluid outlet temperature for evaluating the heat exchange between the first and second fluids by comparing the estimated second fluid outlet temperature, or a parameter derived therefrom, with a reference value.

2. A method according to claim 1, characterized in the reference value is a predetermined second fluid outlet temperature.

3. A method according to claim 1, characterized in using the estimated second fluid outlet temperature for establishing a second heat rate of the second fluid for evaluating the energy balance of the second heat rate of the second fluid compared to a first heat rate of the first

fluid.

4. A method according to claim 3, characterized in establishing the second rate of heat flow of the second fluid by establishing an estimate of a second fluid mass flow and a specific enthalpy change of the second fluid across the heat exchanger based on the estimated second fluid outlet temperature and the second fluid inlet temperature, and the condensation pressure.

5. A method according to claim 3 or 4, characterized in establishing the first rate of heat flow by establishing a first fluid mass flow and a specific enthalpy change of the first fluid across the heat exchanger based on parameters representative for first fluid inlet and outlet temperatures.

6. A method according to any of the claims 3-5, characterized in establishing a residual as difference between the first heat rate and the second heat rate.

7. A method according to claim 2, characterized in establishing a residual as difference between the estimated and predetermined second fluid outlet temperature.

8. A method according to claim 6 or 7, characterized in providing an abnormality indicator by means of the residual, the abnormality indicator being provided according to the formula:

$$S_{\mu,i} = \begin{cases} S_{\mu,i-1} + s_i, \text{ when } S_{\mu,i-1} + s_{\mu,i} > 0 \\ 0, \text{ when } S_{\mu,i-1} + s_{\mu,i} \le 0 \end{cases} \quad (20)$$

where $s_{\mu,i}$ is calculated according to the following equation:

$$s_{\mu,i} = c_1\left(r_i - \frac{\mu_0 + \mu}{2}\right) \quad (21)$$

where
r_i: residual
c_1: proportionality constant
μ_0: first sensibility value
μ: second sensibility value.

9. A heat exchanger abnormality detection device for a heat exchanger (3, 5) exchanging heat between a first fluid (7) in a conduit (6) and a second fluid (8) in a flow path (9), characterized in that the device comprises a first estimator estimating at least one parameter representative of the temperature conditions of the heat exchanger, a first intermediate memory means storing the at least one parameter representative of the temperature conditions of the heat exchanger, a temperature sensor measuring the second fluid inlet temperature, a second intermediate memory means storing the second fluid inlet temperature, a second estimator establishing a parameter indicative of expected heat exchange between the heat exchanger (3, 5) and the second fluid (8), a third intermediate memory means storing the parameter indicative of expected heat exchange, a processor establishing an estimated second fluid outlet temperature based on said at least one parameter representative of the temperature conditions of the heat exchanger , said second fluid inlet temperature, from the first and second intermediate memory means, respectively, and, from the third intermediate memory means, the parameter indicative of expected heat exchange, and a comparator comparing the estimated second fluid outlet temperature, or a parameter established on basis thereof, with a reference value.

10. A detection device according to claim 9, characterized in that the detection device further comprises memory means for storing at

least one parameter from the processor.

11. A detection device according to claim 9 or 10, characterized in that the heat exchanger (3, 5) is part of a vapour-compression refrigeration or heat pump system (1) comprising a compressor (2), a condenser (3), an expansion device (4), and an evaporator (5) interconnected by conduits (6) providing a flow circuit for the first fluid (7), said first fluid (7) being a refrigerant.

12. A detection device according to claim 11, characterized in that the heat exchanger (3, 5) is the condenser (3).

13. A detection device according to any of the claims 9-12, characterized in that the second fluid (8) is air.

14. A detection device according to any of the claims 11-13, characterized in that the condenser (3) is part of a refrigerated display cabinet positioned within a building and the condenser (3) is positioned outside the building.

15. Use of a detection device according to any of the claims 9-14, characterized in that the detection device is used for detecting fouling of the heat exchanger (3, 5) and/or detecting insufficient flow of the second fluid (9).